Preliminary Notes on Genyornis newtoni; a New Genus and Species of Fossil Struthious Bird found at Lake Callabonna, South Australia.

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and

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Some account of the discovery of fossil remains at Lake Callabonna, by one of us, appeared in "Nature," 1894, Vol. L., pp. 184 and 206. Since then various circumstances which were alluded to at the time, besides considerable difficulties in connection with the restoration and treatment of the bones have retarded the development of the discovery and the publication of the results; nevertheless, though the work of dealing with a large mass of material is still far from complete, we find ourselves, at last, in a position to offer to this Society some preliminary notes upon the subject in respect of the remains of the large struthious bird which were found in association with bones of *Diprotodon* and other extinct marsupials.

As, in the course of this paper, reference will have frequently to be made to previous discoveries, in Australia, of bones of the same group of birds it will be convenient to commence our observations by a brief epitome of these.

That work has been materially facilitated by a paper by Mr. Robt. Etheridge, junr., who, in a paper in the "Records of the Geological Society of New South Wales," † succinctly reviews the history of the various discoveries of struthious birds in Australia. From this paper we have freely borrowed, and we accordingly express our thanks and acknowledgment.

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* Justice requires an acknowledgment on my part that to Mr. Zietz belongs the credit not only of having conducted the exhumations at Lake Callabonna, under arduous circumstances, but also of having most successfully carried out the tedious work of the restoration of bones which presented peculiar difficulties in treatment. I must be the first to admit that collaboration on my part has only been made possible by the patient and laborious exercise of Mr. Zietz's skill in this direction.—[E. C. S.]

† On Further Evidence of a Large Extinct Struthious Bird (*Dromornis*, Owen) from the Post-Tertiary Deposits of Queensland. R. Etheridge, jun., Vol. I., p. 126.

The first evidence of the former existence of these birds in Australia appears to have been in 1836, when "Sir Thomas Mitchell, F.G.S., Surveyor-General of Australia, discovered in the breccia-cave of Wellington Valley a femur," (13 inches in length), "wanting the lower end, having the lower ends mutilated, and encrusted with the red stalagmite of the cave, which I determined to belong to a large bird, probably, from its size, struthious or brevipennate, but not presenting characters which, at that time, justified me in suggesting closer affinities."* This femur is figured in Mitchell's work.†

In 1865 or 1866 (the alternative dates are given because both appear in two different notices by the author), at Penola, South Australia, the Rev. J. E. Tenison Woods came into possession of "two tibias and two tarso-metatarsal bones of some extinct and very large bird."‡

There is a further discrepancy in Mr. Woods' notices of the discovery in respect of the position in which the bones were found, for, in one place, he states that they were found "in sinking a well,"|| and, in another, that they were found "near a native well."§

In a subsequent reference ¶ Mr. Woods provisionally proposed the name of *Dromaius australis* for this bird.

An important part of Mr. Woods's statements concerning it is the expression of his belief in its contemporaneity with man. He says in the first-mentioned notice that "It is certainly quite extinct, but appears to have been contemporaneous with the natives, for these bones are marked with old scars, one of which must certainly have been inflicted by a sharper instrument than any in the possession of the natives at present; there were, however, fragments of flint buried with the bones, and a native well about 50 yards away."

We have not been able to examine these bones, nor even do we know what has become of them. Perhaps they are among those fossils which, we understand, lie hidden in obscurity in the Penola Institute, and we propose to investigate the question. If, however, the statement of Mr. Woods concerning the contemporaneity of the bones with man can be substantiated it is one of

* On *Dinornis*, Trans. Zool. Soc., Owen vol. VIII., p. 381; also Extinct wingless birds of New Zealand (*Dromornis australis*). Appendix, p. 1.

† Three Expeditions into the Interior of Eastern Australia, 1838, vol. II., pl. 32, figs. 12 and 13; 1839 ed. pl. 51.

‡ Report on the Geology and Mineralogy of the South-Eastern District of South Australia by the Rev. J. E. Tenison Woods, p. 7.

|| *Ibid.*

§ Nat. History of New South Wales—An Essay, p. 27 (quoted from Etheridge, *op. cit*).

¶ Proc. Linn. Soc., N.S.W., 1883, VII., p. 387.

the greatest importance as affording, so far as we know, the only direct evidence of the coexistence of man in Australia with the extinct fauna.

Mr. Woods' description of the bones is not very clear, but a certain interpretation of it lends support to the view that the bones in question were those of the bird for which we shall propose the generic name *Genyornis.*

In 1869, the late Rev. W. B. Clarke, Government Geologist of New South Wales, announced, both to the *Sydney Morning Herald* (May 19) and to the *Geological Magazine* (Vol. VI., p. 383), the discovery of a femur (nearly twelve inches in length) during the digging of a well at Peak Downs in Queensland. As Mr. Etheridge points out there is, in this case also, some discrepancy in the statements as to the exact position in which the bone was found. This femur was determined by Mr. Krefft, then Curator of the Australian Museum, to be that of a *Dinornis.*

A cast of it, with photographs, was transmitted to Professor Owen who described it in detail and founded on it the genus *Dromornis*; summarized his conclusions as follows:—"I infer that in its essential characters this femur resembles more that bone in the emu than in the moa, and that the characters in which it more resembles *Dinornis* are concomitant with, and related to, the more general strength and robustness of the bone—from which we may infer that the species manifested dinornithic strength and proportions of the hind limbs, combined with characters of closer affinity to the existing smaller, more slender-limbed, and swifter wingless bird peculiar to the Australian continent."*

In 1876, again through the instrumentality of the Rev. W. B. Clarke, a fragment of a pelvis of a large bird, including the left acetabulum, found at a depth of 200 feet, at the Canadian Gold Lead, near Mudgee, N.S.W., was transmitted to Professor Owen, who assigned it to *Dromornis.*† In the same paper he describes a portion of a tibia, supposed to have come from a cave at Mt. Gambier, South Australia.‡ This also Professor Owen allocated to *Dromornis,* but remarks "one cannot of course state confidently that it is a bone of the same species as the mutilated femur from the cave of Wellington Valley, or of that of the drift at Peak Downs, in Queensland." We believe that this fragment may be assigned to *Genyornis.*

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* Trans. Zool. Soc. Vol. VIII., p. 383. Extinct wingless birds of New Zealand. Appendix, p. 13.

† Trans. Zool. Soc., 1877, Vol. X., p. 186. Extinct wingless birds of New Zealand. Appendix, p. 6.

‡ This was presented to the British Museum by the Trustees of the Adelaide Museum, 1872.—Brit. Mus. Cat. Fossil Birds, p. 356.

In the proceedings of the Royal Society of Queensland, for 1884 (Vol. I., p. 23), Mr. De Vis describes a fragment of the proximal end of a femur of a struthious bird that was discovered, with other bones, at King's Creek, in the Darling Downs district. In the author's opinion the characters of this fragment justify its reference to the genus *Dinornis*, and he accordingly assigned to its possessor the name *Dinornis queenslandiæ*. This conclusion has, however, been contested by so competent an authority as Professor Hutton, and no doubt requires the confirmatory evidence of more complete material.

In 1889 remains of a large struthious bird were found at an old spring, in sinking a well, at a depth of 20 feet from the surface at Thorbindah, near Cainwarra Station, on the Paroo River, Queensland, in association with fragments of bones of kangaroos, *Diprotodon*, and *Dromæus*, and forwarded to the Government Geologist by Mr. A. S. Cotter. These were described by Mr. Etheridge in the paper to which we have expressed our indebtedness as portions of "the right tibia and left fibula of a large struthious bird, and the right tibia of an emu;" both of the portions of the larger bones were assigned by the author to *Dromornis*.

As to the fragment of tibia, we can have no doubt that it belongs to the same bird as the Mount Gambier and Callabonna fossils; but to this matter we must recur. The fragment, however, believed by Mr. Etheridge to be a part of the fibula, is certainly not any part of that bone in the Callabonna bird, and, indeed, we cannot make it correspond to any part of *Genyornis* which we possess, nor, moreover, does it correspond to any part of any fossil bone with which we are able to compare it, whether of bird or mammal.

As we are dealing particularly with the larger forms of struthious birds, we do no more than mention, in this place, that fossil fragments of bones, which have been referred to the existing genus *Dromæus*, have been recorded from the Post-Tertiary deposits of the Wellington Caves and other localities. One such fragment, from the Darling Downs, of slightly larger dimensions than the living species *Dromæus novæ-hollandiæ*, constitutes the type of *Dromæus patricius*,* which name was accepted by Mr. Etheridge for the fragment found at the Paroo River with the larger bones.† So also a fossil representative of *Casuarius* (stated to be allied to *C. picticollis*, Lydekker, Brit. Mus. Cat. Fossil Birds), in the form of a distal portion of the tibio-tarsus, was also obtained in the cave deposits of Wellington Valley.

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* "A Glimpse of the Post-Tertiary Avi-fauna of Queensland," Proc. Linn. Soc. N.S.W., 1888, Vol. III., 2nd ser., p. 1277.

† Records Geol. Surv. of N.S.W., *loc cit.*, p. 133.

Up to this point these references are based upon published statements, which have been so conveniently summarised by Mr. Etheridge. We may now add to the list by a notice of some other discoveries in South Australia, which have either not yet been made public or which have only received a passing notice in the current press.

In 1879 the South Australian Museum received, from Mr. R. M. Robertson various collections of fossil bones found near Normanville, South Australia. Amongst these, which included remains of *Diprotodon*, *Macropus*, *Phascolomys*, *Bettongia* and *Thylacoleo*, were a portion of a femur and of two or three tibiæ. We are now able to refer all the latter to the Callabonna bird.

In 1889 one of us (A.Z.), in the course of the exhumation of *Diprotodon* bones at Baldina Creek, on the edge of the Eastern Plains, near Burra, South Australia, obtained a considerable portion of a femur, which can also be referred to the same species.

Lastly, in 1893, came the discovery, already noticed in "Nature,"* of a large number of bird-bones at Lake Callabonna found in association with those of *Diprotodon* and of other extinct marsupials. To the circumstances of this discovery, so far as it relates to the birds, a few further details will be given directly.

For convenience of reference we may now epitomise, in their proper order, the various discoveries of large bird bones which have been mentioned above.

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* *Loc. cit.*

Date.	Locality.	Colony.	Discoverer, or Author (in brackets).	Nature of Remains.
1836	Wellington Caves ...	N.S.W.	Sir T. Mitchell	Femur, mutilated
1865 or 6	Penola...	S.A.	Rev. J. E. Tenison Woods ...	Two tibiæ and two metatarsi
1869	Peak Downs (Dromornis)	Q.	Rev. W. B. Clarke	Femur
1876	Canadian Lead ...	N.S.W.	Mr. Dietz	Portion of pelvis
1876 or 7	Mount Gambier ...	S.A.	(Prof. Owen)...	Fragment of tibia
1879	Normanville	S.A.	Mr. R. M. Robertson ...	Portions of femur and of three tibiæ
1884	King's Creek	Q.	(Mr. C. W. De Vis)... ...	Portion of femur
1889	Paroo River	Q.	Mr. A. S. Cotter	Portion of tibia: of fibula?
1889	Baldina Creek... ...	S.A.	Mr. A. Zietz...	Portion of femur
1893	Lake Callabonna ...	S.A.	Mr. A. Zietz ... ... Mr. H. Hurst	Many bones, *vide infra*

Geological Age of the Various Bird Remains.

As to the geological age of the various bones Mr. Etheridge remarks :—" The femora " (Wellington Caves, Peak Downs and King's Creek) " and the tibia " (Mount Gambier) " coming from what may be generally termed Quaternary deposits may, for argument's sake, be considered of the same geological age. But it is questionable if the pelvis from the Canadian Lead can be so regarded. As previously stated it was found at a depth of 200 ft. in an auriferous lead of supposed Pliocene age, and it is therefore somewhat premature to class these remains as all of one period. Rather, would it not be better to consider the pelvis from the Canadian Lead as one of the earliest bird remains yet extant on this continent, and of Pliocene age ; and those from the other localities as representing a Post-Pliocene period." *

As to the Penola remains the discrepancies in Mr. Woods' statements as to their position have already been alluded to, but the expression of belief from a geologist in the contemporaneity of the bird with the natives and the distinct assertion, in one of his notices of the remains, that they were found " in one of the kitchen middens of the natives of South Australia. The bones were marked by the scrapings and cuttings of the flint knives of the blacks," at least implies a recent period. †

With regard to the Normanville and Baldina Creek fossils we are informed by Mr. Howchin that some uncertainty exists as to whether the deposits in which they were found should be regarded as Pliocene or Pleistocene.

At Callabonna the fossiliferous formation was determined by Professor Tate ‡ to be Pliocene.

The Discovery of Bird-bones at Lake Callabonna.

Some reference was made to the discovery of bird-bones in the papers in " Nature " already referred to, but it may not be without interest to add, in this place, a few further details. These we quote in the first person singular as proceeding from the one of us (A.Z.) who personally conducted the operations at Lake Callabonna.

" The level bottom of Callabonna Lake, the characters of which have been described,‖ shows, in some places, small elevations of about two square feet in size,§ formed of concretionary lime-

* Op. cit., p. 129.

† Proc. Lin. Soc., N.S.W., 1882, Vol. VII., p. 387.

‡ " Nature," 1894, Vol. L., p. 207.

‖ " Nature," Vol. L., p. 187.

§ These elevations are distinguished from those covering the skeletons of Kangaroos and Diprotodons by their smaller size and by the presence of pebbles.

stone. These, when closely examined, were found to form incrustations for the more solid bird bones. Around, and above, these elevations were scattered numerous small smooth pebbles,* which were partly buried in drift sand. The elevations could still be recognised during the dry season, when the whole bed of the lake was covered with a white saline incrustation.

"The remains of the first two birds found were imperfect skeletons of which only the leg and toe bones (which were underground) could be removed, all the other bones being irretrievably damaged. Subsequently, when the clay bottom of the lake became sufficiently dry and hard for camel riding, I made a flying trip of two days duration to the north-western shore of the lake, about eight miles distant from our camp, where, I was told, bird bones had been noticed in greater number. The result of this trip, however, proved to be unsatisfactory, only a few bones being obtained and these in a very defective state.

"In the course of time, while proceeding with the exhumation of *Diprotodon* fossils near our permanent camp, single bird bones were frequently found mixed with those of the former animal; but in many cases they were destroyed before they were noticed. This was unavoidable, because, in order to gain access to the large *Diprotodon* bones which were to be removed, great masses of clay had to be shifted, and it was in the course of this removal that the accidental damage took place to the smaller and unnoticed bird bones which were disseminated in the clay. Judging from the frequency with which its remains were found, this bird must have been numerous at the time of its existence. During the second month's operations we discovered a nearly perfect sternum —the only good specimen obtained—and near to it other parts of a skeleton scattered throughout the clay. All, however, except the sternum were in a very bad condition. In the course of the third month a part of the lake, near our camp, which was, at the time of our arrival, partly under water and too boggy for work, became partly dry, owing to the continuance of dry northerly winds.

"To this place I decided to give a trial with the result that three bird skeletons, besides other fossils, were found lying close together and only about a foot below the surface. The first bone uncovered was a pelvis, and on following this up we came upon the vertebral column which was, however, in a hopeless state of decay; near the end of this was the lower jaw. Perceiving also, with great delight, parts of the skull, I decided to extract the whole mass of surrounding clay in which it was embedded. The second skeleton was in a similiar condition:—head only partly recognisable; pelvis good; sternum, both in this and the previous

* "Nature," Vol. L., p. 208.

specimen, broken up into fragments; vertebræ little interrupted as a series, but each individual segment broken into minute fragments which made it impossible to remove them whole. One wing was nearly complete, but the bones of the other were only in fragments; caudal vertebræ in fair condition. The legs of all the birds found were directed downward, and were in a flexed position. The lower end of the tibio-tarsus, the tarso-metatarsal and toe bones were invariably incrusted with hard limestone to the thickness of half an inch, which had to be chipped off, and in the course of removal of this crust some bones were injured. The lower ends of the legs extended to a depth of several feet under ground where water was always present. The third bird skeleton was rather incomplete:—head in fragments; pelvis imperfect; no sternum; the legs only were in good condition. The remains of these three birds were found within a space of about six square yards and, as they lay on one side, their heads and necks were directed towards the south-west—the deepest part of the lake bed. It may be mentioned that all the bones situated near the surface were always found broken up into innumerable fragments, which was due to the growth of tufts of fibrous crystals.

[We are indebted to Mr. E. F. Turner, Demonstrator of Chemistry at the University, for the following note on the constitution and formation of these crystals:—The material submitted consists of clay impregnated, and covered, with filiform crystals, which are composed of halite, together with smaller quantities of gypsum, glauberite and alunite. On saturating the mass of clay with water, and then allowing it to dry, the crystals again appeared on the surface—capillary attraction leading the saturated solution of the above salts to deposit, in the first place, the cubical crystals of common salt and the octahedral crystals of alunite; these then become bound together by the prismatic crystals of glauberite and gypsum, the result being that a protruding mass of filiform crystals is formed.]

"Under atmospheric influences, in which dry conditions of the clay are succeeded by moist, these crystals are alternately formed, in and around the bones, and redissolved; with the result that constant scaling takes place from their surfaces until at last the whole bone crumbles into fine powder. Or, short of this, the infiltration of the bones with so much salt confers on them such hygrometric properties that, even in an ordinary damp atmosphere, they become moist, and can only be dried with great difficulty; while, on the other hand, in the very dry weather of the Australian summer they become brittle to an extreme degree. The shrinkage, on drying, and consequent cracking of the masses of clay, enveloping the bones, also constituted a cause of damage. To give some idea of the extent to which this took place it may be mentioned that a block of clay, containing bones which filled a box about 15 inches square, developed cracks in two places each over an inch in width. Such facts will in some measure explain the difficulties and delays that have been experienced in connection with the restoration of these bones.

"It may perhaps be mentioned in this place that, on one occasion, the white incrustation of saline crystals which then covered the surface of the lake was completely blown off by the force of the wind, leaving bare the natural clay of its bed.

"The appearance on the surface of skeletons, particularly of *Diprotodon*, is, no doubt, to be explained by a similar and recurring action of the wind, which, at certain seasons, blows with great force and frequency on the desiccated surface of the clay itself. *Vide* 'Nature,' vol. L., p. 210.

"The position of the sternum was always indicated by the presence of the gravel masses, previously mentioned, which rested upon its concave (upper) surface, whether on, or below, the ground. Though a few fragments of birds' bones were obtained before my arrival on the field, nearly all of them were obtained towards the latter part of my stay. Short of an exact enumeration it may be stated that the material obtained comprises about six femora, three only being in really good condition, the others unfortunately much distorted, by pressure, or otherwise injured; the tibio-tarsi, tarso-metatarsi, and toe bones of about a dozen birds, the majority of these being now in an excellent state of completeness and preservation; one almost perfect sternum; one skull a good deal damaged with its hyoid bone, and parts of a second head with the greater portion of its lower jaw; one nearly complete wing, with portions of others; two ribs; one set of caudal vertebræ and three pelves—the latter being much broken, partly by rabbits in camp (*Vide* 'Nature,' vol. L., p. 210), partly in transit, and partly on account of the conditions just described."

Existing Nomenclature of the Large Australian Fossil Struthious Birds.

So far as this is concerned the position is as follows:—

The genus *Dromornis* was founded by Professor Owen, on the Peak Downs femur, and the author has, at least provisionally, referred to the same genus the first found femur of the Wellington Caves, the fragment of the pelvis of the Canadian Lead and the portion of the Mount Gambier tibio-tarsus. "The probabilities are" says Professor Owen, in a letter to Mr. Clarke,* "that the femur from the breccia cave of Wellington Valley, that described (from Peak Downs), your portion of a pelvis, and the South Australian tibia are parts of the same genus if not species. It is

* Journal and Proc. R. Soc. N.S.W., 1877, Vol. XI., p. 43.

more convenient and conducive to progress to regard them, until proof of the contrary be had, as parts of *Dromornis australis*." This was somewhat qualified by a later statement already quoted, which very reasonably implied that it must still be an open question as to the specific identity of the Mt. Gambier tibia with the femora of the Wellington Valley and Peak Downs.*

The Kings Creek fragment of femur has been assigned by Mr. DeVis to the genus *Dinornis* as *D. queenslandiæ.*

For the Penola bones the Rev. J. E. Tenison Woods provisionally proposed the name *Dromaius australis* until more bones should be found, but "since then its remains have been found in other places, and Professor Owen has named it *Dromornis australis*."†

Putting aside, as not immediately concerning us, the fossil forms of emeu, *Dromornis australis* and *Dinornis queenslandiæ* are thus the only two definitely named species of large extinct Australian struthious birds.

From an examination of the bones of the Callabonna bird, so far as this has proceeded, and, in the first place, from a comparison of its femur with these two named Australian species,‡ we believe we may assert that—

1. The femur of the Callabonna bird differs so considerably from that of *Dromornis* and *Dinornis queenslandiæ* that it must be regarded as that of a different bird, and, further, that the differences are sufficiently great to justify the establishment of a separate genus.

2. The Mount Gambier and the Paroo River tibiæ, assigned to *Dromornis* by Professor Owen and Mr. Etheridge respectively, are identical with that bone in the Callabonna bird. As to the supposed fragment of fibula from the latter locality, we have already expressed our doubts.

3. Of the portion of the Canadian Lead pelvis, we cannot yet express an opinion, as no comparison has yet been made with that of the Callabonna bird, which is, moreover, much damaged, and still in process of restoration.

4. The other South Australian specimens from Normanville and Baldina Creek are identical with corresponding parts of the Callabonna bird.

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* Extinct wingless birds of New Zealand. Appendix, p. 6.

† Nat. Hist. N.S.W., 1882, p. 27 ; (quoted from Etheridge) p. 135.

‡ We have to express our acknowledgement to Mr. Etheridge and Mr. DeVis, Curators, respectively, of the Australian and Queensland Museums for forwarding to the South Australian Museum casts of these two type specimens, and to Mr. Pittman, Director of the Geological Survey of New South Wales, for his courtesy in permitting us to examine the actual specimens from the Paroo River, described by Mr. Etheridge.

Now, as the name *Dromornis* rightly belongs to the Peak Downs femur on which the genus was founded, it becomes necessary to find a name for the Callabonna fossil, whose femur is different, and we propose the name *Genyornis** *newtoni*. The generic name arises from the conspicuous feature afforded by the relatively large size of the lower mandible, which fact, at least, emerges from the, as yet, hardly commenced examination of the skull.

Under this name, therefore, we propose to include the various portions of tibiæ that have been hitherto assigned to *Dromornis*, leaving the identity of the Canadian Lead pelvis as yet undetermined.

Genyornis newtoni.

A detailed description of the bones of this bird, together with a comparative reference to the other forms with which it may be compared, and the necessary illustrations, are in course of preparation. In the meantime we submit the actual specimens to the Society, and beg to call attention to a few salient features that may give some indications of its characters and of its affinities, particularly with those Australian and New Zealand ratitite birds which are the first to invite comparison.

Femur.—This bone of *Genyornis*, in its bulk and massive proportions, claims comparison with that of the most ponderous of the moas. Though, as will be seen by reference to table I. the largest examples are nearly five inches shorter, yet, their latitudinal dimensions very nearly equal those of *Dinornis maximus*, while they considerably surpass those of *Pachyornis elephantopus*. From the the femora of Dinornithidæ that of *Genyornis* is, however, distinguished by the marked absence of prominent ridges and surfaces for muscular attachment that are often conspicuous features in the former family; by the flatness of the surfaces of the shaft; by the pyriform oval, or almost trilateral, shape of the section, and by the more considerable curvature of its internal border. It differs also in the more gradual and evenly curved ascent of its superior articular surface, as it recedes from the head to cover the trochanter. Yet notwithstanding, from the great lateral width of this surface, the trochanter rises to as great or to a greater elevation, relatively to the head, than obtains in the moas, where the ascent of the epitrochanteric surface is abrupt and steep. The femur of

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*Γένυς, the under jaw. In the specific name we have much pleasure in dedicating this ancient bird to Professor Alfred Newton, F.R.S., Professor of Zoology in the University of Cambridge, whose name has been long intimately and honourably associated with the progress of ornithology and, from whom, both as teacher and friend, one of us has received much personal kindness and encouragement.

Genyornis differs also from that of these birds in the presence of alarge pneumatic foramen at the topmost part of the posterior surface of the upper expansion of the shaft. In this respect it resembles the femur of the emeu and ostrich, while it differs from that of the cassowary. Great differences are also observed in the shape and proportions of the great trochanter.

The inferior extremity is also characterised by its great breadth and, in conformity thereto, the width of the inter-condylar groove in the largest examples exceeds by an inch that of the femur of *D. giganteus*, Owen."*

From the femur of *Dromornis* that of *Genyornis* is distinguished by its more massive proportions as shown in table I., and by some of the above mentioned characters, such as the shape of the section of the shaft (which in *Dromornis* is a flattened and regular oval); the marked curvature of the internal border; the presence of the pneumatic foramen and the shape and projections of the trochanter with its accessory processes. In one respect there is a resemblance to *Dromornis*, viz., in the gradual and even slope upwards of the superior articular surface towards the trochanter. So far as the mutilated condition of the *Dromornis* femur permits a comparison to be made there are also considerable differences in the details of the inferior extremity —particularly in respect of the contrast between the oblique, deep and narrow popliteal depression in this bone and the wider, shallower, and much less well defined cavity as it exists in *Genyornis*.

Whether further remains of the bird to which the fragment of femur, named *Dinornis queenslandiæ* by Mr. DeVis, belongs shall prove it undoubtedly to be an undoubted *Dinornis* or not, the sudden ascent of the trochanteric part of the articular surface of this bone in the Moas is in marked contrast to the feature that has been described for Genyornis. A further distinction in *D. queenslandiæ* is the considerable fore and aft projection of the trochanter which, in a smaller bone, gives a greater width of the postero-external trochanteric surface than in the larger femur of *Genyornis*.

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* The South Australian Museum does not possess a femur of *D. maximus*.

TABLE I.

Table showing comparative measurements of the femora of *Genyornis newtoni*, *Dinornis maximus*, *Dinornis (Pachyornis) elephantopus*, and *Dromornis australis*.

—	*Genyornis newtoni.* No. 1.		*Genyornis newtoni.* No. 2.		*Genyornis newtoni.* No. 3.		*Dinornis maximus*, Owen.		*Dinornis elephantopus*, Owen. *Pachyornis elephantopus*, Lydekker.		*Dromornis australis*, Owen.	
	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.
Length	$13\frac{3}{8}$*	339	$13\frac{5}{8}$*	345	13*	322	$18\frac{1}{4}$	462	13	329	$11\frac{1}{2}$*	291
Breadth of proximal end	$6\frac{3}{8}$*	161	$7\frac{1}{8}$	180	$6\frac{3}{8}$	161	$6\frac{1}{2}$	164	$5\frac{10}{12}$	147	$5\frac{1}{4}$*	133
Breadth of distal end ...	7	177	$6\frac{3}{4}$	171	$6\frac{3}{8}$	161	$7\frac{1}{2}$	190	$5\frac{11}{12}$	149	5*	126
Circumference at middle	$9\frac{1}{4}$	234	$9\frac{1}{4}$	234	$8\frac{5}{8}$	218	$9\frac{1}{2}$	240	$7\frac{3}{4}$	196	$6\frac{3}{4}$	171

For convenience of reference the measurements are given both in inches and millimetres.

The asterisk indicates that the measurements so marked are slightly curtailed by reason of abrasion of the bones.

Nos. 1 and 2 of *Genyornis* represent a pair of bones.

The measurements of *D. maximus*, *D. elephantopus*, and *Dromornis* are from Professor Owen's Table of Measurements, Trans. Zool. Soc., vol. VIII., p. 371.

The *Tibio-tarsus*, which in point of size may be compared with that of Pachyornis elephantopus (*vide* Table II.), is brought into line with the Dinornithidæ by the presence of a supra-condyloid extensor bridge, but this is in *Genyornis*, nearly median in position, instead of being near the inner border as in the former family.

The statement previously made, which assigned the Mount Gambier and Paroo River tibias to *Genyornis* now requires some further explanation. For, in Professor Owen's description of the former fossil,* he states that of the " bridge there is no trace . . . . and there is no evidence of fracture of the piers of such a

* Trans. Zool. Soc., vol. VIII., p. 381., also Extinct wingless birds of N.Z., appendix, p. 5.

bridge. The margins of the groove whence the bridge springs in *Dinornis* are in *Dromornis* broadly convex and entire." And again, in Mr. Etheridge's paper so frequently referred to,* it is stated, in speaking of the Paroo River fossil, that "the rounded edge of the precondylar groove at that point in the present bone, whence in *Dinornis* the piers of the bony bridge, or oblique bar would spring, are much worn away, and would at first convey the impression that a similiar structure had here existed. By following the general contour of the groove, however, and comparing with this the mechanism in a *Dinornis* tibia it is quite apparent that such a structure could not have existed in the present instance, and we are therefore dealing with a true *Dromornis* bone." Now the preciseness of these statements and the sources from which they emanate are of such a character that it requires some assurance to suggest that they have been made in error. Further, we should have ourselves to admit that, had our own notice been based upon some of the Callabonna bones, we should have been compelled to make a similiar assertion as to the absence of a bony bar. We have specimens in which the margins of the groove at the site of the bridge are so worn as to leave no trace of the previous existence of such a structure. Fortunately, however, in one specimen the bridge is *in situ* and perfect in its form and attachments; in two others the osseous attachment to one pier is intact though, on the opposite side of the groove, a narrow gap, extending though the whole width of the bar, separates the end from its corresponding pier; in others, though the bridge itself is absent, the condition of the margins clearly indicates its former existence. Mr. Pittman, Director of the Geological Survey of New South Wales, has very courteously forwarded the Paroo River fragment for our examination, and we find that the appearances presented by the piers in this bone are exactly paralleled by those of some of the Callabonna tibiæ. We have, therefore, no hesitation in asserting that the bar was once present in this bone also.

As to the Mt. Gambier specimen described by Professor Owen, we are only able to refer to his plate. The margins of the groove where the bridge ought to be are there certainly shown as in a very worn condition, but not more so than in some of our own specimens, while there is so close a correspondence in other details of the bone that we have no doubt of its identity with the tibia of *Genyornis*.

In the tibio-tarsus of *Genyornis* there is a much more abrupt inward deflection of the tendinal groove, which takes place just at the place where it is spanned by the bridge, than we find in

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* *Op cit.*

any of the Dinornithidæ. The Callabonna tibia is, moreover, characterised by a very marked inflection of the lower end of the shaft, and particularly by the incurvature of its inner border—these features being markedly in excess of those which obtain in Pachyornis. A very conspicuous feature of the *Genyornis* tibia is the massive proportions of the cnemial process, the elevation above the articular surface to which it reaches and the marked recurvature of the ecto-cnemial ridge to the extent of forming what might be described as a hamular process. In this combination of characters there is a much greater resemblance to the emeu than to the Dinornithidæ.

Table II.

Table showing comparative measurements of the Tibio-tarsi *Genyornis newtoni* and *Dinornis (Pachyornis) elephantopus.*

	Genyornis newtoni.		*Dinornis elephantopus* Owen. *Pachyornis elephantopus*, Lydekker.	
	Inches.	Mm.	Inches.	Mm.
Length	$23\frac{3}{4}$	602	24	608
Breadth of proximal end ...	7 5/[illegible]	193	$7\frac{5}{12}$	187
" " distal end ...	4	101	$4\frac{1}{6}$	105
Circumference at middle ...	$6\frac{3}{4}$	164	$6\frac{5}{12}$	162

The *Genyornis* tibia belongs to one of the large pair of femora of the preceding table, and the measurements of that of *D. elephantopus* are from Owen's table.

The *tarso-metarsus* equals in length that of *Dinornis ingens*, Owen, but its latitudinal measurements are superior to the latter, in all respects except in that of the width of the distal end. Beyond this relative narrowness of the combined trochleæ these elements are, in *Genyornis*, distinguished by their inequality of size—the inner being only half the width of the outer and very slightly shorter and the outer only two-thirds of that of the mid-trochlea. The surfaces that bound the trochlear interspaces are markedly concave, and there are two perforations through the bone just above the outer trochlear interspace. In these features there is a closer resemblance to the emeu than to the cassowary,* in which latter there is nearly equality of size between the inner and outer trochleæ and no perforation in the interspace, while in the former there is a single perforation. In general proportions, however, there is a nearer approach to the latter bird than to the

* *Casuarius australis.*

more slender-legged emeu. The marked trilateral character of the transverse section of the upper half or two-thirds of the bone, and the deep longitudinal grooving of the corresponding anterior surface, constitute conspicuous features and, to some extent, further points of resemblance to both emeu and cassowary. The hypotarsus is thick, prominent and undivided.

No sign of the attachment of a hallux appears.

Table III.

Table showing comparative measurements of the tarso-metatarsi of *Genyornis newtoni*, *Dinornis novæ-hollandiæ* (*ingens*), Owen, and *D. gracilis*, Owen.

—	*Genyornis newtoni.*		*Dinornis novæ-hollandiæ*, Owen. *D. ingens*, Owen.		*Dinornis gracilis* Owen.	
	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.
Length	$13\frac{3}{4}$	348	$13\frac{3}{4}$	348	13	329
Circumference at middle ...	$5\frac{3}{8}$	135	$4\frac{1}{2}$	114	$4\frac{1}{4}$	107
Breadth (tranverse) of distal end	$3\frac{1}{2}$	88	$4\frac{1}{2}$	114	$4\frac{1}{4}$	107
Transverse breadth at middle	$1\frac{7}{8}$	47	$1\frac{7}{12}$	40	$1\frac{7}{12}$	40
Antero-posterior breadth at middle	$1\frac{1}{2}$	38	$1\frac{1}{4}$	32	$1\frac{1}{6}$	30
Breadth of proximal end ...	$3\frac{3}{4}$	95	$3\frac{1}{2}$	88	$3\frac{1}{3}$	84

The *Genyornis* tarso-metatarsus does not belong to the same bird as the femur and tibio-tarsus. The measurements of the other bones are from Owen's table.

Toes.—The toes of the tridactyle foot are remarkably short in comparison to those of the Dinornithidæ, the middle one being only just as long, and the inner and outer hardly more than an inch longer than the respective digits of the emeu. In relative size they conform to the proportions of the corresponding trochleæ, and in the great slenderness of the inner toe we have another point of resemblance to *Dromæus*. This digit is further characterised by the lateral compression and great relative length of its proximal phalanx; the lengths of the three proximal phalanges of an average specimen being as follows:—Inner, 80 mm.; middle, 73 mm.; outer, 65 mm. The phalanges of the middle and outer toes, on the contrary, are characterised by their breadth and depression. The, ungual phalanges, in particular are small, short and flat—features which are in marked contrast with the long, pointed and curved, conical claw-bearing phalanges of the Dinornithidæ, or even of those of the emeu and cassowary. In conformity with the shape of the constituent segments (except in the case of the inner toe) the surfaces of the phalangeal joints are characterised by their transverse width and low vertical height; by their comparative flatness, and by the insignificance of the depressions for the lateral ligaments—a combination of characters which indicate weakness of the toes, in addition to the shortness and feebleness of the claw-bearing phalanges.

One other important feature remains to be indicated. From all other ratitite forms, and from nearly all other birds, the outer toe of *Genyornis* differs in possessing only four segments in place of five. Of this unusual feature the one of us (A.Z.) who gathered the bones assured himself repeatedly by counting them *in situ*.

Sternum.—The restoration of this bone is not yet quite completed, but, so far as can be seen in shape and proportions, it resembles that of the emeu more closely than it does that of the cassowary, while it differs considerably from that of the Dinornithidæ. We think we may confidently assert that neither lateral xiphoid processes nor median post-axial notch exist.

The actual dimensions may be thus approximately stated:—Extreme length, 12 inches; extreme transverse breadth, allowing for a slight deficiency, $10\frac{1}{2}$ inches. The corresponding measurements of the sternum of the emeu and cassowary *(C. australis)* being respectively $4\frac{1}{2}$ and 4 inches, and 8 and $5\frac{1}{2}$ inches.

Wings.—By the fortunate recovery of several elements of wings we are able to establish the possession of small appendages of this character for *Genyornis.* The humerus, radius, ulna, two meta-carpals, and one phalanx are represented either by complete bones or by fragments. The whole length is approximately $9\frac{1}{4}$ inches, and the proportions, on the whole, more nearly those of the emeu than the cassowary.

Head.—As to the head, of which both specimens obtained are unfortunately in a very dilapidated condition, we prefer not to speak at present, except to indicate its large size. The total length of the skull is $11\frac{1}{2}$ inches, that of a large emeu and ostrich being respectively $6\frac{1}{8}$ and 8 inches.

As concerns the size of the lower mandible, from which feature the bird has received its name, we may mention that the ramus, slightly imperfect at its posterior extremity, is $10\frac{1}{8}$ inches, and its width at the widest part $2\frac{1}{2}$ inches. The symphysial depth is $1\frac{1}{2}$ inches. For a large ostrich and emeu the corresponding measurements are respectively, in inches, $7\frac{1}{4}$, $3\frac{1}{4}$, $\frac{5}{8}$; and $5\frac{3}{4}$, 3, $\frac{7}{16}$. The transverse span, posteriorly, of the lower mandible is, at least, 6 inches, while that of the ostrich and emeu is $3\frac{1}{4}$ and 3 inches respectively.

Thus far, in our brief description, we have made comparisons only with Australian and New Zealand ratitite birds existing and fossil. Two other extinct forms invite comparison, viz., *Gastornis parisiensis*, from the Eocene beds of Meudon, near Paris, and the *Æpyornis maximus*, of Madagascar; but, for the present, we must content ourselves with saying that, though in that characteristic part—the lower end of the tibia—there are points of resemblance between *Genyornis* and *Gastornis*, yet, so far as can be judged by reference to plates and descriptions, which are our only means of comparison in the case of *Gastornis*, we believe the differences in respect both of the characters of the femur and tibio-tarsus, to say nothing of the difference of geological horizon, are sufficient to preclude even a generic association between the two forms.

Between *Genyornis* and *Æpyornis* there are many conspicuous points of difference; though it is noteworthy that, in point of great breadth as compared to length, the femur of *Genyornis* makes a nearer approach to that of *Æpyornis maximus* than the thighbone of any other bird with which we are acquainted.

Conclusions.

Though in the absence of a careful study of so important a part of the organization as the head, it is perhaps premature to offer decisive opinions as to the habits of the bird or of its affinities with existing members of its group, nevertheless the following conclusions appear to be justified by the survey of its remains so far as this has been made.

The great size of the femur and tibio-tarsus, no less than of its sternum, indicate its massive build, though there is a strange disproportion between the proportions of the upper leg bones and the relatively slender tarso-metatarsus. Its legs combine a huge femur nearly as massive, in all but length, as that of *Dinornis maximus*, and a tibia equalling that of *Pachyornis elephantopus* with the comparatively slender metatarse of *Dinornis novæ-hollandiæ (ingens)* and toes whioh are insignificant beside any of the larger moas. The absence of prominent rough surfaces or ridges for muscular attachment, lead one to assign to it a slow sluggish habit. In height it may be confidently stated to have been from 6 feet to 6 feet 6 inches, that is if the neck should have been of proportions similiar to those of *Pachyornis elephantopus.* With the large size of the head, however, may be correlated modifications of the neck. The small flat ungual phalanges would appear to have borne flattened nails, rather than sharp and powerful claws, which could have been of little service for scratching purposes and with this feature is associated an evident want of strength in the phalangeal joints.

There is reason to believe that the *Diprotodon* may have been a swamp-loving animal which, tapir-like, may have haunted the shores of the lacustrine areas of Central Australia in Pliocene times, and the association of the remains of *Genyornis* with those of *Diprotodon* suggest that the bird, too, may have had its haunts, and found its food, by the same swamps as its bulky marsupial associates. The thickness of the lower jaw is scarcely commensurate with its great length and depth, and this fact, with the weakness of the toes, suggest that, like the emeu, herbage, rather than roots, may have formed its food.

In the course of our brief description and comparisons it will have been seen that the resemblance to the emeu, and to a less extent to the cassowary, are many and considerable. The presence of the bony bridge being, however, a conspicuous, if not morphologically important, point of difference. The emeu, in fact, appears to be its nearest ally, though there are points of resemblance, other than in respect of bulk, to the *Dinornithidæ*, and possibly it may be found to the *Gastornithidæ*. We may, perhaps, provisionally regard it as an ancestral form of emeu, possibly having relations to the New Zealand group.

As will be seen in table I. certain differences in size exist between the femora of two individuals, and these are not confined to that bone; but we do not believe that, either in this respect or in the details of structure, there will be found grounds for thinking that more than one species is represented in the Callabonna collection.

Of its relations to existing forms, other than those of the ratitite type which have been mentioned, it is premature to speak; such facts will emerge with greater certainty and completeness on a study of the head, the restoration of which—a long and tedious task—is approaching completion, though, unfortunately, it is in a very imperfect condition. In the meantime we believe we have, in this preliminary notice, sufficiently indicated, though in a manner less complete than we could have wished, the interesting nature of the discovery at Callabonna, not only as affording additional evidence, in so much more complete a form than has hitherto existed, of the wide range in Australia of this race of great extinct birds, but also as bearing upon the phylogenetic relations of the sub-class to which it belongs, as well as, possibly on the question of the former distribution of land in the Southern Hemisphere.

These points, however, must be left to a subsequent communication, and, perhaps, to those with a wider range of knowledge than is possessed by the authors of this paper.

Genyornis newtoni — A Fossil Struthious Bird from Lake Callabonna, South Australia.

Description of the Bones of the Leg and Foot.

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and

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Plates III., IV., and V.

[Read October 6, 1896.]

A preliminary notice of this bird appeared in the Transactions of the Royal Society of South Australia, vol. XX., p. 171. In the present paper we offer the first part of that which, when complete, will be a detailed description of all those parts of the skeleton which we possess. We commence with the bones of the leg, as the restoration of these is now nearly finished. Further notices will appear as other bones become available for description.

Femur:—Of these bones three only are in anything like perfect condition. A fourth, though nearly entire, is much flattened by antero-posterior compression, and others are still more distorted or imperfect. That which has principally served as the type for description is No. 3 of Table I. Though the dimensions of this are somewhat smaller than those of the large pair comprising Nos. 1 and 2, it is in a better state of preservation than either of the latter—indeed, save for slight abrasions affecting the summit of the trochanter, and for depressed areas on the upper part of the hinder and the lower part of the front surface, the anatomical details are almost perfect.

The head approximately equals, but does not exceed, the proportions of a hemisphere; and the part corresponding to the neck is but feebly defined by a very trifling constriction, which does not, however, involve the superior aspect. The non-articular part of the under surface of the neck, as it ascends, encroaches somewhat on the otherwise nearly hemispherical head. The depression for the round ligament is shallow, and situated well upon the upper surface of the head (Pl. iii., fig. 3, *A*). The superior articular surface, after descending from the summit of the head, ascends, as it recedes outwardly to cover the trochanter, with a very gradual and slightly curved incline* (Pl. iii., fig. 2 *C*)—a feature which is in marked contrast to the more abrupt and steeper rise of this process in *Dinornis.* Nevertheless, owing to the great lateral width of the upper extremity of the bone and the consequent length of the incline, the summit of the trochanter, even in its slightly abraded condition, reaches to quite as great a relative height above the head, as in the New Zealand birds.

When a proximal view of the superior extremity is presented (Pl. iii., fig. 3) it will be seen that there is no projection posteriorly of the hinder surface of the trochanter, such as there is both in the New Zealand *Dinornis* and in *D. queenslandiæ.* Thus, whereas in the last named birds and, to some extent also, in *Dromornis*, the posterior margin of the upper articular surface forms a well-marked indented curve. In *Genyornis*, however, it forms nearly a straight line up to the point where the contour of the trochanter sweeps forward (Pl. iii., fig. 3, *upper border of figure*). The same figure will indicate the manner in which the mass of the trochanter is projected forwards and outwards (*B*).

In *Dinornis* the pre- meets the postero-external trochanteric surface at an acute angle, and the crest, corresponding to their line of union and terminating below in the ecto-trochanteric tuberosity, is sharp, prominent and laterally compressed. In *Genyornis*, on the other hand, the conditions may, perhaps, be best described as being such as are produced by the inclination towards one another of two plane, or, at most, very slightly concave, surfaces (pre- and ecto-trochanteric) at little less than a right angle, the angle along the line at which these two surfaces meet being at the same time broadly rounded off, instead of forming a prominent crest. Thus, though the anterior production of the trochanter is considerable, the process lacks the lateral compression, which is a conspicuous feature in all the *Dinornis* femora to which we have access. An obscurely indicated rough surface, rather than a distinct ecto-trochanteric tuberosity, marks the subsidence upon the shaft of the anterior trochanteric prominence (Pl. iii., fig. 1 *E T*). The pre-trochanteric surface (Pl. iii., fig. 1 *D*) is nearly flat, and does not present an oblique line or ridge, nor the conspicuous subcircular area for muscular attachment, which is shown in various *Dinornis* femora. The latter feature may, however, be represented by an irregular elevation, obscurely represented in Pl. iii., fig. 1, at the junction of the anterior and inferior surfaces of the neck close to the head.

* In Pl. iii., fig. 1, the steepness of the ascent of the trochanteric part of the articular surface is much exaggerated owing to the foreshortening, in the photograph, of the anterior projection of the mass of the trochanter itself.

From the absence of production posteriorly of the trochanter, the width of its postero-external surface is relatively less broad than in *Dinornis* and, though protuberant and roughly striated externally, it presents no marked depressions or elevations. On the outer surface of the trochanter an obscure, obtusely angular ridge runs from its summit obliquely downwards and backwards.

A feebly-marked intermuscular ridge (Pl. iii., fig. 1 *F*) beginning to the inside of the rough surface, which corresponds to the ecto-trochanteric tuberosity (Owen), descends vertically for two inches, and then inclines inwards to merge into a ridge which leads to the front of the ento-condyle. Immediately to the outside of the point where the inclination inwards takes place is a slightly elevated rough surface which is scarcely manifest in the figure.

The posterior surface of the upper expansion of the bone has undergone some amount of distortion by the depression of a considerable area of its outer crust—(Pl. iii., fig. 2 *G*), but the other femora show this tract and, indeed, the whole of the posterior surface to have been very flat. The posterior margin of the upper articular surface, as this begins to rise on to the trochanter, projects considerably so as to form an overhanging ridge. Directly below this ridge is a large deep oval depression (Pl. iii., fig. 2 *H*) which is clearly a pneumatic orifice. Two large foramina, separated by a bony septum, lead from the bottom of the depression into the interior of the bone.

The shaft is remarkably smooth and, with the exceptions above mentioned, is devoid of the prominent muscular ridges, rough surfaces or elevations that characterise Dinornithine femora; particularly, on the posterior aspect, is there an absence of lineæ asperæ. One very small nutrient foramen is present at about the centre of this surface.

A characteristic feature of this bone is the marked curvature of its internal contour (Pl. iii., figs. 1 and 2) in which respect it contrasts with the more open curve in the femora of *Dinornis* and *Dromornis*. The flatness of the posterior surface has been mentioned; to a hardly less extent the anterior and exterior surfaces are flat also, while the inner is rounded. Thus the transverse section in the middle of the shaft is a pyriform oval with the small end corresponding to the inner surface, or it might almost be described as trilateral.

The lower extremity, of which an area of the crust on the front surface has been depressed (Pl. iii., fig. 1 *G*) is, like the upper, characterised by its great transverse breadth—the smallest of the Callabonna bones exceeding, in this respect, the corresponding measurement of a femur of *Dinornis giganteus* (Owen), in the Museum collection, having a length of 15 inches, while the similar width in the largest approaches to within half an inch of that of *Dinornis maximus* (Owen) with a length of $18\frac{1}{4}$ inches. Conformably to the great width of the lower extremity is the breadth of the rotular channel ($2\frac{7}{8}$ inches) (Pl. iii., fig. 4 *R C*) which also slightly exceeds the breadth of this channel in the femur of *D. giganteus* (Owen). At the same time the channel is, in *Genyornis*, relatively shallow. The anterior intercondylar ridge is very slightly indicated (Pl. iii., fig. 4 *N*), while the posterior is narrow and prominent (Pl. iii., fig. 2 *O*) ; the region corresponding to the intercondylar fossa is prominent rather than depressed.

Owing to the gentle inclination of the posterior surface of the shaft, as it leads into the popliteal fossa (Pl. iii., fig. 2 *J*), this depression is ill defined as to its superior contours, and the external and internal ridges which bound it laterally are broadly rounded, especially the former. The floor of the fossa is flat, but rough, and there are large pneumatic orifices arranged in a row along the lower margin (Pl. iii., fig. 2, above *O*). The larger depression seen at a higher level is probably accidental, as it does not appear to exist in the other bones. The open and shallow characters of the fossa in this bone contrast with the better defined, oblique, deep and narrow cavity in *D' omornis*. Commensurate also with the great breadth of the lower end is the width of the ento-condyle (Pl. iii., fig. 4 *I C*), of which the contour of the posterior margin forms nearly a horizontal line (*M*) before it dips suddenly to become the internal margin of the posterior intercondyloid notch (*K*); the contour of this notch forms a U-shaped figure instead of a more open curve.

Of the ecto-condyle (*E C*) the tibial moiety is also relatively wide, exceeding, in this respect, the corresponding part in *Dinornis giganteus*, and the fibular groove, is continued fowards for a considerable distance on to the front of the ecto-condyle; just behind the posterior limits of the groove there is an irregularly elongated ecto-condylar fossa (Pl. iii., fig. 2 *P*). The depression on the outer surface of ecto-condyle is inconspicuous, beside that to be observed on most Dinornithine birds. The ecto-condyle, moreover, when the bone is held vertically reaches a considerably lower level ($1\frac{1}{4}$ inch) than the ento-condyle; thus to place the bone in the position that the most inferior part of each condyle rests upon the same horizontal level involves a very considerable obliquity of the shaft.

Except in respect of size, all the Lake Callabonna femora resemble one another so exactly, that there can be no doubt that they belong to the same species. We have elsewhere expressed the opinion* that two fragments of femora from

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* Trans. R. Soc., S.A., vol. XX., p. 175.

Normanville and Baldina Creek, S.A., are also to be attributed to the same bird, but it should be stated that, though corresponding with the Callabonna femora in all anatomical details which are available for comparison, the former fragments are parts of bones of distinctly less size than the smallest of the latter, as shown by the fact that their circumference, at the part corresponding to the mid point of the entire bone, is nearly an inch and a half less. In the portion from Baldina Creek, however, enough of the bone exists to permit of a comparison in many details, and in these as stated, no essential differences can be detected.

Table I.

Showing dimensions of femora of *Genyornis newtoni* compared with those of some other femora.

—	Length.		Breadth of proximal end.		Breadth of distal end.		Circumference at middle.	
	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.
Genyornis newtoni, No. 1	$13\frac{3}{8}$*	339	$6\frac{3}{8}$*	161	7	177	$9\frac{1}{4}$	234
Genyornis newtoni, No. 2	$13\frac{5}{8}$*	345	$7\frac{1}{8}$	180	$6\frac{3}{4}$	171	$9\frac{1}{4}$	234
Genyornis newtoni, No. 3	13*	322	$6\frac{3}{8}$	161	$6\frac{3}{8}$	161	$8\frac{5}{8}$	218
Dromornis australis, Owen	$11\frac{1}{2}$*	291	$5\frac{1}{4}$*	133	5	126	$6\frac{3}{4}$	171
Dinornis maximus, Owen	$18\frac{1}{4}$	462	$6\frac{1}{2}$	164	$7\frac{1}{2}$	190	$9\frac{1}{2}$	240
Dinornis elephantopus, Owen ... (*Pachyornis elephantopus* Lydekker) ...	13	329	$5\frac{10}{12}$	147	$5\frac{11}{12}$	149	$7\frac{3}{4}$	196
Æpyornis maximus, I. Geoffroy	$12\frac{5}{8}$	320	$6\frac{5}{8}$	170	$7\frac{1}{2}$	190	$10\frac{5}{8}$	270

For convenience of reference the measurements are given both in inches and millimetres.

The asterisk indicates that the measurements so marked are slightly curtailed by reason of abrasion of the bones.

Nos. 1 and 2 of *Genyornis* represent a pair of bones—the largest in the collection.

The measurements of *D. maximus* and *D. elephantopus*, are from Professor Owen's Table of Measurements, Trans. Zool. Soc., vol. VIII., p. 371; those of *Æpyornis* from Oiseaux des Iles Mascareignes A. Milne Edwards, p. 96; and those of *Dromornis* partly from Owen's description, Extinct Wingless Birds of New Zealand, Appendix p. 2, and partly from a cast.

Tibio-tarsus.—Of these bones two only, viz., those belonging to the large pair of femora, Nos. 1 and 2 of Table I, are undistorted and nearly perfect, having suffered only some abrasion of the procnemial crest; in two others the full length has been preserved, but they are considerably crushed and distorted. In four it has been possible to restore the whole length of the shaft, but the processes of the upper extremity are absent. The remainder, sixteen in number, are represented only by the lower end, usually in good condition, with more or less of the shaft.

The ento-condylar surface (Pl. iv., fig. 5, *I C*) is suboval and nearly flat in its longer axis, which is directed obliquely from behind forwards and inwards. In the shorter axis it is slightly concave.

The ecto-condyle (Pl. iv., fig. 5, *E C*) is smaller in size, markedly convex, and oval, with its longer axis nearly at right angles to that of the entocondyle. An ill-defined intercondylar channel, scarcely to be distinguished in the figure, separates these two surfaces posteriorly and follows the contour of the ecto-condyle in a direction forwards and outwards to the ecto-cnemial cavity. (Pl. iv., fig. 5, *J*). There is a prominent smooth intercondylar eminence (Pl. iv., fig. 5, *A*) the inner slope of which forms part of the entocondylar surface. The eminence also bounds the intercondylar channel in front and, in part, the cnemial or rotular channel (*B*) posteriorly. The posterier margin of both articular surfaces overhang the shaft considerably.

In front of the cnemial channel, which is wide and shallow, the massive cnemial process (Pl. iv., figs. 1, 3, 4, 5) rises to nearly three inches, measured vertically, above the level of the articular surface, this great height of the process being contributed to by the extension of the upper end of the procnemial ridge above the level of the epicnemial crest (Pl. iv., figs. 1, 3, 4 *F*). The procnemial ridge is thick at its upper part, but soon narrows as it descends to a much laterally compressed crest (Pl. iv., figs. 1, 3, 5, *F*), which, even in its somewhat damaged condition, is very prominent; this is continued down the front of the shaft to a point nearly six inches below its summit. About this point the crest subsides to a low, but still well marked, ridge, which is continued obliquely downwards and inwards till it almost reaches the inner margin of the anterior surface of the shaft at a little below the middle of the bone (fig. 1, *K K*). From this level the ridge extends vertically downwards for about four inches, but with diminished prominence, lying just external and parallel to the inner margin of the front surface of the shaft. Finally the ridge acquires increased prominence, inclines outwards and eventually becomes continuous with the inner border of the supracondylar extensor groove (figs. 1, 6, *L*).

The epicnemial crest (using the term to include the whole upper border of the cnemial process, exclusive of the procnemial summit), when viewed superiorly, forms an open sigmoid curve (Pl. iv., fig. 5, *E E H)*, which is so inclined that its lower and outer end is considerably below the level of its upper and inner. The former end terminates by a marked backwardly directed curve *(H).* In fact, the external angle of the cnemial process might be described as forming a backwardly directed hamular process, the inferior border of which forms the beginning of the ectocnemial ridge (Pl. iv., figs. 1, 4, *H G).* This ridge, or crest, is continued downwards, with an inward trend, to a point which lies about four inches below the point of the hamular process; here it subsides upon the shaft, having at its termination approached to within an inch of the procnemial ridge.

Internally the cnemial process is bounded by a thick and rounded border (Pl. iv., figs. 3, 5 *D)* formed by the meeting of its posterior surface with the internal surface of the procnemial crest. This border descends abruptly from the summit of the process, but with an inclination backwards and inwards (figs. 3, 5, *D).* On meeting the upper expansion of the bone this descending border becomes continuous with the adjacent, somewhat elevated and ridge-like anterior margin of the inner part of the rotular channel. There is thus no considerable extension of the epicnemial crest beyond, and to the inside of, the procnemial as in *Dinornis;* the latter ridge, in fact, springs from the interior surface of the former quite close to the thick and abruptly descending inner border that has been described.

Owing to the posterior incurvation of the angle formed at the junction of the epicnemial and ectocnemial crests, the ectocnemial cavity lying between this angle and the outer margin of the ectocondyle forms a deeply indented bay (fig. 5, opposite *J*), of which the arms approach one another to within two and a half inches.

No distinct supra-fibular facet is observable; in fact, when the fibula, which nearly certainly belongs to one of the large pair of tibio-tarsi, is placed in position, the head of the former does not touch that of the latter by nearly half an inch. The fibular ridge begins, as a low rising, two inches below the overhanging external edge of the ectocondylar surface, the interval being smooth and deeply concave in a vertical direction. An inch and a half below its beginning the ridge widens into a rough and nearly flat elevated surface, of fusiform outline, for articulation with the fibula (Pl. iv., fig. 4, *O O*). This surface, which is four inches long by five-eighths of an inch broad, appears to represent the whole extent of the direct articulation between the two bones. A smooth interval of about an inch succeeds this surface, and below this again an ill-defined broad, rough ridge that represents the external surface of the shaft, proceeds to the lower outer condyle. The opening of a larg nutrient artery, directed distalwards, and to which a groove leads from above, lies just behind the lower end of the articular surface that has been described.

On the antero-internal aspect of the upper expansion of the bone an obtusely angulated ridge descends for four inches from the corresponding margin of the articular surface. This ridge terminates in a roughened convex tuberosity (Pl. iv., fig. 2, *P*). The tract between this ridge and the procnemial crest is nearly flat, or only very slightly concave in its upper part, where the surface is uninjured; the lower part has suffered some depression from injury.

Above the level of the (lower) fibular articulation the shaft is sub-quadrangular in shape, and at the same time somewat antero-posteriorly compressed. This latter characteristic continues throughout the rest of the shaft, but below the fibular surface the sub-quadrangular section becomes more of a pyriform oval, the smaller end being external; at the lower end the section tends to become again somewhat quadrilateral. The lateral width which, at the upper level of the fibular articulation, is $3\frac{1}{8}$ inches, diminishes in the descent to $2\frac{1}{8}$ inches at the narrowest part of the bone, which is 5 inches above its lower end; below this there is a slight increase of width as the shaft expands into the condyles. There is also a slight diminution of the antero-posterior diameter of the shaft in passing from above downwards.

At a little above the point at which the bone has been described as narrowest, laterally, there begins a marked deflection inwards of the lower end of the shaft, and the inflection affects the inner border to a greater extent than the outer. The result is to cause a considerable production inwards of the inner condyle. There is, at the same time, a slight but marked deflection forwards of the lower extremity. These features are shown in the whole length figures of the bone.

Of the lower expansion the inner condyle projects more, both anteriorly and posteriorly (Pl. iv., fig. 7), particularly in the former direction, than the outer. The whole antero-posterior width is also greater than that of the latter, (93 mm. to 73 mm). In lateral width the condyles are nearly equal. Held with the long axis perfectly vertical, the ectocondyle reaches a slightly lower level than its fellow. (Figs. 1, 2).*

When the two condyles are held at the same horizontal level their articular surfaces ascend in front to about the same level, but the upward extension of the inner, besides its greater prominence anteriorly, preserves a more uniform width than that of the outer, which latter becomes in its upper part reduced to a

* In Fig. 6, the axis is not quite vertical.

narrow tract (Fig. 6.) The superior contour line in front of the conjoined articular surfaces, though sufficiently distinct to form the inferior boundary of the supracondylar space, does not form a so marked a ridge as in *Dinornis*. Posteriorly, the corresponding contour line (not very distinctly marked and not distinguishable in Fig. 2) slopes downwards and inwards from the summit of the outer condylar region to that of the inner where it becomes continuous with the compressed and projecting postero-external ridge in which the inner condyle terminates behind.

When viewed from below the intercondylar channels, in front and behind, yield contours, the forms of which are seen in Pl. iv., fig. 7. The same figure shows the greater extent of the anterior production of the inner condyle, but it does not show very conspicuously another character which is to be noticed, viz., the greater lateral width of the whole trochlear surface in front than behind, the last-mentioned feature being due to the fact that, as the infero-internal border of the inner condyle sweeps backward it also inclines outwards, trending towards the corresponding border of the other side, the curve of which scarcely departs from a true antero-posterior plane. The degree of curvature of the inferior contour of the trochlear surface is shown in Figs. 1, 2, 6.

The greater part of the front of the inner surface of the ento-condyle is occupied by a large gibbous or nearly oval depression, of which the margin anteriorly and inferiorly comes right up to the edge of the articular surface. (Pl. iv., fig. 3, *Q*.) Behind the depression, about midway between the anterior and posterior border of the condyle, is an obtusely rounded, epicondylar, tuberosity (Fig. 3, *R*) which is not very prominent, and scarcely projects beyond the plane of the lower border of the condyle.

The external surface of the outer condyle (Fig. 4, *E C*) is nearly flat, or only very slightly concave, over its whole extent, and possesses no epicondylar tuberosity.

The supra-condylar extensor groove *(M)* may be discerned as commencing about six inches above the condyle on the outside of the ridge *(K)* described as leading downwards from the termination of the procnemial crest. The ridge is, in fact, continuous with the inner border of the groove. (Fig. 6, *KL*).

As the groove descends it deepens, and inclines outwards until it reaches the mid line, at which point it is spanned by the bridge (fig. 6, *S*). At this level the groove is deflected inwards at a somewhat abrupt angle, and below the bridge the groove is distinguishable as a broad, shallow canal, which emerges into the wide, but not deep, supra-condylar fossa. Of the borders of the groove, the inner *(L)* is the more prominent and rugose, and the outer *(M)* smooth. The bridge itself, median in position, and placed very obliquely, stands prominently forward, especially in regard to its lower edge.*

The width of the bridge is 15 mm. at its outer end, from which point the breadth increases towards the inner side, the increase being due to the increasing obliquity of the upper border. Owing to the loss of a small piece which has been chipped out of the upper border near the inner pier the width at this end cannot be exactly stated, but would appear to have been 19 mm. The lower border of the bridge is considerably thicker than the upper, and somewhat everted. The lower outlet is oval, and its plane looks downwards and inwards, while the upper outlet forms a shorter, as well as narrower, oval than the lower.

In the canal covered by the bridge is a large pneumatic foramen which encroaches on the outer pier.

Close to the outer edge of the bone, and on a level with the outer pier, is a rough, obtusely conical tuberosity. (Fig. 6, *T*). In conformity with the more median position of the bridge, as compared with *Dinornis,* that tract of the lower expansion which lies internal to this structure, is much wider in *Genyornis* than in the New Zealand genus, and the continuation of this tract below the bridge, which forms the incline into the supra-condylar fossa, is in the former broad and somewhat transversely convex, in contrast to the condition in *Dinornis,* where it is pinched into more or less of a ridge. The distance from the middle of the lower border of the bridge to the nearest point of the internal condyle is 28 mm.

The dimensions of one of the large pair of tibio-tarsi are shown in Table II. Owing to the absence, or distortion, of parts of the upper end, it is impossible to state accurately the length in the great majority of specimens. That feature which is most perfectly preserved in nearly all of them is the lower end, and we therefore use the lateral width dimension of this for the purposes of comparison in point of size. We find that, among 24 tibio-tarsi in which perfection of the lower end permits accurate measurement to be stated, the width varies from four inches in the largest example to three and a quarter in the smallest. All but eight have a greater measurement than three and a half inches, and in none of the bones is there any evident sign of an immature condition.

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* The bridge is absent in both the large and nearly perfect pair of tibio-tarsi, and, in fact, from all but four of the specimens. The details respecting it are therefore taken from another specimen (that represented in fig. 6), comprising only the lower extremity and part of the shaft. In this the feature in question is perfect except for a small piece which has been chipped out of its upper border. *Vide* Trans. Roy. Soc. S.A., Vol. XX., p. 185.

TABLE II.

Showing dimensions of tibio-tarsus of *Genyornis newtoni* in comparison with those of the tibio-tarsi of *Dinornis elephantopus*, Owen *(Pachyornis elephantopus*, Lydekker), *and Æpyornis maximus.*

—	Length.		Breadth of proximal end.		Breadth of distal end.		Circumference of middle.	
	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.
Genyornis newtoni...	$23\frac{3}{4}$	602	$7\frac{5}{8}$	193	4	101	$6\frac{3}{4}$	171
Dinornis elephantopus, Owen ...	24	608	$7\frac{5}{12}$	187	$4\frac{1}{6}$	105	$6\frac{5}{12}$	162
Æpyornis maximus, Geoffroy ...	$25\frac{1}{4}$	640	$7\frac{1}{2}$	190	$5\frac{5}{16}$	135	$6\frac{1}{4}$	158

The *Genyornis* tibia belongs to one of the large pair of femora of the preceding table. The measurements of that of *Dinornis elephantopus* are from Owen's tables and those of *Æpyornis* from Milne Edwards's work previously quoted, p. 93.

Fibula.—(Pl. iv., figs. 8, 9.) This bone presents the usual laterally sub-compressed and backwardly produced head. The superior articular surface—that upon which the femur plays—is an elongated oval, slightly concave antero-posteriorly, and nearly flat transversely. It is not coextensive with the whole upper surface of the head, but leaves a non-articular area in front which slopes more abruptly downward and forward. Lying obliquely athwart the internal surface of the head is an elongated depression or groove (Fig. 9, *A*) which is directed towards the edge of the articular surface of the tibio-tarsus, though the absence of a distinct corresponding facet on that bone has been mentioned. Externally the head is also slightly concave in antero-posterior direction.

The upper part of the shaft is sub-compressed in the same direction as the head, but soon becomes sub-circular in section. A little below the head on the anterior surface is a small tuberosity. With the commencement of the lower articular surface for the tibio-tarsus, about 5 inches below the summit, the shaft increases in size, becoming at the same time sub-triangular in section, the outer surface being convex, the postero-internal nearly flat, and the anterior somewhat concave.

The lower articular surface for the tibio-tarsus (Fig. 9, *B*) is an elongated rough area about three inches in length, which at its upper part is provided at the expense of the internal angle of the, in this situation, trilateral shaft, but as it descends it encroaches more and more upon that surface of the shaft described as postero-internal till it comes to occupy nearly its whole width. A rough oval tuberosity (Figs. 8, 9, *C*) is developed upon the posterior border of the shaft a little below the level of the commencement of the articular surface, and below this there is a gradual reduction in the size of the shaft which, moreover, loses its trilateral character. Below the articular surface the shaft assumes the form of a cone, which in most of the specimens tapers rather abruptly to a blunt point. In the longest specimen the taper is more gradual, and the length below the articular surface, in this, is consequently greater.

The length of a large fibula, apparently complete as to its length, and of about the same size as an imperfect specimen belonging to one of the large tibio-tarsi, is $9\frac{7}{8}$ inches, while that of the smallest is $8\frac{1}{2}$ inches. The antero-posterior diameters of the heads of these two bones, measured obliquely in the direction of the longer axis, are $2\frac{7}{16}$ inches and 2 inches respectively. Seven fibulæ, only, were collected, but these are all in good preservation with the exception of the lower pointed extremity, which is broken off in most of them.

Tarso-metatarsus.—The ecto-condylar surface (Pl. v., fig. 3, *E C*) is subquadrangular and flat, with a slight slope downwards as it extends outwards. That of the ento-condyle (fig. 3, *I C*) somewhat exceeds a semicircle in shape; its transverse diameter is about equal to, and the antero-posterior diameter greater than, those measurements in the ecto-condyle. In the latter diameter it is slightly concave, and in the former greatly so, this character being principally due to the elevation of the inner margin into an elevated lip or crest (*A*), which rises a little higher than the anterior entocondylar process. This crest frequently exhibits a slight, externally directed curvature (fig. 1, *A*). The intercondylar tract, marked at about its centre by a shallow depression, rises in front into an obtusely angulated intercondylar process (fig. 1, *B*).

On the posterior aspect of the upper extremity there is a single thick, prominent and undivided hypotarsus (Pl. v., fig. 2, *C*) which rises above the articular surface as a sub-conical prominence, and reaches a somewhat greater elevation than the anterior intercondylar process. The inner surface of the hypotarsus is marked by a shallow groove which begins a little below its summit and curves somewhat forwards as it descends. This groove disappears under a broad but thin bridge of bone (fig. 2, *D*) which covers the opening of the posterior ent-interosseous canal, and below this it continues more or less distinctly for some distance down the postero-internal surface of the shaft.

The hypotarsus extends, mesially, down the shaft as a broa angular ridge with gradually diminishing elevation, which, how ever, may be traced to within two inches of the posterior limits of the me-sotrochlea. As the ridge subsides a shallow groove commences on its inner side (fig. 2, *G*), which leads to the inner trochlear interspace.

On the front surface of the upper expansion there is a large interosseous depression, with declivous sides (Pl. v., fig. 1, *E*), the upper margin extending to within about an inch and a half of the summit of the anterior intercondyloid process. At the bottom of this pit are the anterior openings of the interosseous canals. Immediately below this depression, and encroaching upon its inferior slope, is a rough vertically striated surface for attachment of the tibialis anticus (fig. 1, *between E and F).* Immediately below this rough surface is the upwardly directed opening of a nutrient artery (fig. 1, *F*), to which a slight groove leads from below.

Above the large depression into which the interosseous canal opens anteriorly, the surface of the bone is transversely concave, and below it, also, the whole of the front surface of the shaft is occupied by a wide groove which becomes narrower and shallower as it descends; at a little below the middle of the shaft the groove has disappeared, and the front surface is flat transversely, below this, again, the same surface becomes more and more transversely convex with the increasing prominence of the meso-tarsus. An ill-defined shallow groove on the front surface of the lower third of the shaft, scarcely to be distinguished in the figure, leads to the outer intertrochlear interspace.

On the outer surface of the head there is a prominent, antero-posteriorly flattened keel-like process (Pl. v., figs. 1, 3 *H*) which commences a little below the outer margin of the articular surface, and extends downwards as a crest or ridge for from 2 to 2½ inches. This crest and its ridge-like continuation forms the posterior boundary of a shallow groove upon the upper part of the outer surface of the ecto-metatarsus.

The outer side of the hypotarsus, is the large posterior opening of the ect-interosseous canal (Fig. 2., *J).* The opening of its fellow on the opposite side is, as has been stated, concealed by a bridge of bone. The upper-margin of the bridge is above, and the lower below, the level of the eclinterosseous canal.

Owing to the shape and prominence of the hypotarsus, the upper half of the tarso-metatarsus yields a trilateral, indeed almost an equilateral, section, the front surface however being reëntrant owing to its deep grooving. With the subsidence of the hypotarsal ridge, the trilateral section passes into an oval, of gradually increasing transverse diameter, as the shaft descends. In the middle third the postero-external surface is marked by an obscure vertical ridge.

There is no trace of the attachment of a hallux.

Of the three trochleæ (*L M K*) the median (*M*) is conspicuously the largest, the external (*K*) the next in size, and the internal (*L*) the smallest. The width proportions being, in a bone 13¾ inches long, 43 mm., 31 mm., and 14 mm. respectively. Their prominence anteriorly, and production inferiorly, are in the same order, though it is only the meso-trochlea which is produced, and that to a slight degree, beyond the plane of the anterior surface of the shaft. Posteriorly all three trochleæ are produced to about the same level and to the extent of little more than half an inch beyond the plane of the posterior surface of the shaft immediately above them.

The meso-trochlea is widest about the level of the tip of the ento-trochlea, the width, however, diminishing considerably from this point both as its surface extends upwards and backwards. The articular surface of this segment bears a well-marked vertical groove, plainly represented in figs. 1, 2, and 4, extending from its commencement to its termination ; its lateral surfaces, especially that on the outer side, are concave. Of the ecto-trochlea the anterior surface slopes backwards as it extends outwards, and bears a very slightly marked shallow groove, barely observable in the figures. Like the meso-trochlea, it diminishes in width from the commencement to the termination of its articular surface ; its inner surface is concave, and on its outer surface is a subcircular depression. The small ento-trochlea preserves nearly the same width throughout its contour ; its surface is convex transversely ; its outer aspect is somewhat concave, and on its inner is a small, shallow depression. Corresponding to the diminishing width, posteriorly, of the trochleæ themselves the trochlear interspaces are wider behind than in front, and that between the middle and outer segment reaches to a higher level than its fellow.

Just above the ecto-trochlear interspace are two foramina, situated vertically above one another ; the lower is separated from the summit of the interspace merely by a bar of bone,* while the other perforates the whole thickness of the lower expansion. The anterior orifices of both of these are shown in Pl. v., fig. 1, *N.* ; in fig. 2 the posterior orifice of the upper one only is visible (*N*). The shallow groove, described as existing on the lower part of the front surface of the shaft, leads towards the upper of these foramina. In one specimen, only, a similar foramen exists between the meso- and ento-tarsus just above the internal trochlear interspace at a level corresponding to that of the upper of the two perforations on the other side.

* In a good many specimens this bony bar which forms the lower boundary of the lower foramen has broken away.

Of the tarso-metatarsi collected twenty-one have been restored to a nearly perfect condition, and to nearly all of these almost complete sets of phalanges can be assigned.

TABLE III.

Showing comparative measurements of tarso-metatarsi of *Genyornis newtoni*, *Dinornis ingens*, Owen, *Dinornis gracilis*, Owen.

—	Length.		Circumference at middle.		Breadth (transverse) of distal end.		Breadth (transverse) at middle.		Antero-posterior breadth at middle.		Transverse breadth of proximal end.	
	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.	Ins.	Mm.	Ins	Mm.
Genyornis newtoni, No. 1; largest specimen	$14\frac{3}{4}$	374	$5\frac{1}{2}$	139	$3\frac{7}{8}$	98	$1\frac{7}{8}$	47	$1\frac{5}{8}$	41	4*	101
Genyornis newtoni, No. 2; medium specimen	$13\frac{3}{4}$	348	$5\frac{3}{8}$	135	$3\frac{1}{2}$	88	$1\frac{7}{8}$	47	$1\frac{1}{2}$	38	$3\frac{3}{4}$	95
Genyornis newtoni, No. 3; smallest specimen	$12\frac{5}{8}$	320	$4\frac{3}{4}$	120	$3\frac{1}{2}$	88	$1\frac{1}{2}$	38	$1\frac{5}{16}$	33	$3\frac{7}{8}$	98
Dinornis ingens, Owen	$13\frac{3}{4}$	348	$4\frac{1}{2}$	114	$4\frac{1}{2}$	114	$1\frac{7}{12}$	40	$1\frac{1}{4}$	32	$3\frac{1}{2}$	88
Dinornis gracilis, Owen	13	329	$4\frac{1}{4}$	107	$4\frac{1}{4}$	107	$1\frac{7}{12}$	40	$1\frac{1}{6}$	30	$3\frac{1}{3}$	84

* Measurement slightly reduced on account of abrasion.

The *Genyornis* tarso-metatarsus (No. 1) belongs to the large femur and tibio-tarsus of the preceding tables. The measurements of the *Dinornis* bones are from Owen's table.

Phalanges.—As recorded in the preliminary notes on this bird,* while the inner and middle toes possess the normal number of segments—three and four respectively—the outer possesses only four in place of the usual number of five. Of this fact there can be no doubt, as they were repeatedly counted in situ ; and, moreover, amongst the large number of sets of phalanges collected, there are none that would supply, or correspond to, the missing segment. In this connection it is interesting to note that Pro-

* Trans. Roy. Soc. of S.A., Vol. XX., p. 188.

fessor Hutton mentions *Euryapteryx gravis*, Haast (= *Dinornis gravis*, Owen = *Emeus gravipes*, Lydekker) and *Euryapteryx ponderosa*, Hutton, as, also, possessing only four phalanges in the outer toe. Trans. N.Z. Institute, Vol. XXVIII., 1895, p. 637.

The extreme length of the three proximal phalanges, in a set of bones belonging to a right tarso-metatarsus 14½ inches long, which were selected for description both on account of their perfection and of the fact that all the bones almost certainly belong to one another, are II., 1, 83 mm., III., 1, 74, mm., IV., 1, 68; the length of the proximal phalanx of the inner toe is thus a characteristic feature of the foot. Besides its great relative length, Phalanx II., 1, is further characterised by its comparative slenderness and the lateral compression of the greater part of the shaft. (Pl. v., figs. 1, 2, *II.*) Its proximal articular surface forms a regular concave oval with the long axis vertical. (Fig. 5 *II.*) This elongated oval form of the articular surface determines the shape of the section of the proximal part of the shaft in which the lateral compression is most marked. From this distalwards, owing chiefly to the inclination of the superior border towards the inferior, the long vertical axis of the proximal part gradually diminishes until the section, just short of the distal articular expansion, becomes a figure that would be nearly circular but for some flattening of the inferior surface. The external surface is distinctly flatter than the internal, and on each side of the distal expansion is a shallow depression, that on the internal face being the smaller. The distal articulation forms a trochlear surface, of which the convexity, in a vertical direction, forms considerably more than a semicircle; transversely, it is slightly concave in its upper part, and markedly so inferiorly.

Phalanx II., 2, has an almost quadrangular outline when viewed superiorly. The section of the proximal articulation is subtriangular, of which one angle is superior, and the base opposite somewhat convex inferiorly and produced further backwards than the angle above it. The upper surface is somewhat saddle-shaped, being slightly concave longitudinally, and convex transversely, while the under surface is slightly concave in both axes. The section, in the middle of the bone, thus forms a segment of a circle less than a semicircle. The distal articulation is somewhat crescentiform, of which the inferior margin, corresponding to the concavity, slopes backwards, and encroaches on the under surface of the bone. Small vascular canals exist on both superior and inferior surfaces.

Phalanx II., 3—the ungual phalanx—is a segment of variable length, but usually very short and depressed, slightly curved, and obtusely pointed, having on each side a more or less continuous vascular groove.

Phalanx III., 1, is distingnished by the height and breadth of its proximal, and the breadth and depression of its distal, end. The contour of the proximal articulation, of which the two principal diameters are nearly equal, is shown in Pl. v., fig. 5 *II.* Generally a low vertical elevation, present only in the inferior half, indicates a partial division into two facets, of which the inner is rather the larger. From the superior and inferior borders of this surface the upper and under surfaces of the shaft incline towards one another, the inclination being greater in the latter. In the middle of the bone the section is a transversely elongated oval, which becomes more flattened towards the distal end. On the under surface, a little in advance of the articular border, are two rough elevations which leave a shallow trough between them. The distal expansion is almost of the same lateral width as the proximal, but between the two ends the shaft is considerably narrower. The distal articular surface forms a trochlea, of which the convexity in a vertical direction exceeds a semicircle. A shallow median groove which extends in the same direction throughout its whole extent divides it into two convexities of about equal lateral width, though, in vertical depth, the inner considerably exceeds the outer. The lateral surfaces of the distal expansion are occupied by depressions, of which the inner is the larger.

Phalanx III., 2, approximates to a quadrangular contour when viewed from above, the length, however, being somewhat greater than the breadth. Its proximal articular surface is ovoidal, with the larger end internal. A very slightly marked vertical rising obscurely indicates a division into two facets, both of which are concave vertically. Of these, the inner facet is slightly the larger. The shaft is very greatly depressed, the lateral diameter, just posterior to the distal expansion, being to the vertical as 31 mm. to 9 mm. The distal expansion itself is also characterised by great breadth and small vertical height ; its articular surface, which extends further back below than above, forms a trochlea, the groove separating the two convexities being very broad and shallow, and the inner moiety slightly the deeper in a vertical direction. A shallow depression for the lateral ligament exists on the outer side of the distal expansion, but it is only feebly indicated on the inner. There may be one or more nutrient foramina on the under surface.

Phalanx III. 3 is considerably broader than long, in the proportion of 34 mm. to 18 mm., and much depressed. The proximal articulation is reniform with the convexity superior and, owing to a slight posterior production of the superior and inferior borders, particularly of the latter, this surface is concave vertically and mesially, but nearly flat on each side. The anterior articular surface is sub-reniform, convex vertically, and slightly encroaches upon the inferior surface. The superior surface of the phalanx is rough and somewhat convex transversely, and the inferior is concave in both directions.

Phalanx III. 4. — This ungual phalanx, which forms an irregularly oval, concavo-convex plate, is broader than long, and does not greatly exceed in length that of its predecessor in the series. The plane of its proximal surface is inclined downwards and forwards, so that it encroaches on the under surface of the bone. The anterior border is broadly rounded. Two large vascular channels, the opening of one of which can be seen in fig. 6, enter just above each basal angle, and are directed forwards.

Phalanx IV. 1.—This segment has somewhat the same form as III. 1 on a smaller scale, the widths of the two bones at their middle points being as 21 mm. to 31 mm., and the lengths, as previously quoted, 68 mm. to 74 mm. Its proximal articular surface (Pl. vi., fig. 5, IV.) is concave and subtriangular with the base inferior. The external angle, at the base, being more prominent than the internal. From each of these angles a rough, rounded ridge is continued forward, on the under surface, for a short distance. The upper surface is convex transversely, the inferior nearly flat, and the section at its middle nearly semicircular. The distal expansion is depressed and has an articular surface of a form very like that of III. 1, except that the vertical depths of the two convexities of the trochlea are nearly equal. There is a depression on each of its lateral surfaces.

Phalanx IV., 2, is much depressed, with a contour and form resembling those of III., 2, only of considerably smaller dimensions.

Phalanx IV, 3, is similar in contour and form to III., 3, but much smaller.

Phalanx IV., 4, is a slightly curved, small ungual phalanx, a little longer than broad; rather larger and more obtusely pointed than II., 3. Just in front of the angles at the base are grooves which lead into vascular canals, which continue forwards in the substance of the bone. Smaller vascular perforations on both upper and under surfaces.

The segments of III. can be at once distinguished by the great breadth and depression of all but the proximal end of the first phalanx. Those of IV. have a general resemblance in form to the corresponding elements of III., but are only about two-thirds the width. The great relative length, slenderness and compression at once indicates II., 1. Ph. II., 2, has the general contour characters of IV., 2, but has only about two-thirds the breadth, and has not the same definite trochlea for its distal articulation

II., 3, is the smallest, and generally the most pointed of th ungual phalanges.

Considered collectively the characteristics of the toes are the depression of the phalanges and of the articulations, with the exception of those with the tarso-metarsus ; the length, slenderness and compression of the proximal phalanx of the inner toe ; the inconsiderable degree of concavity of the proximal articulation surfaces, due in great part to the absence of that production posteriorly of the central part of the superior and inferior borders which exists to a marked degree in the phalanges of the emeu, and to a less, though still to a considerable, degree in *Dinornis*, and which, when present, must contribute materially to the strength of the joints. So also the absence of deep vertical grooving of the distal trochleæ and the shortness, depression and feebleness of the ungual phalanges of *Genyornis* are additional characters which indicate weakness of the toes and a want of security in their joints.

EXPLANATION OF PLATE III.

Genyornis newtoni:—Femur (left); figs. 1-4.

Fig. 1. Anterior surface.
2. Posterior surface.
3. End contour of proximal extremity.
4. End contour of distal extremity.

In figs. 3 and 4 the upper margin corresponds to the posterior surface.

Index to Letter References.

A Depression for round ligament.
B Trochanter.
C Trochanteric articular surface.
D Pre-trochanteric surface.
E Ecto-trochanteric surface.
EC Ecto-condyle.
ET Ecto-trochanteric tuberosity.
F Intermuscular ridge
G.G Depressed areas.
H Pneumatic foramen.
IC Ento-condyle.
J Popliteal fossa.
K Posterior intercondylar notch.
L Fibular groove.
M Posterior border of ento-condyle.
N Anterior intercondylar ridge.
O Posterior intercondylar ridge.
P Ecto-condylar fossa.
RC Rotular channel.

All the figures are half size.

EXPLANATION OF PLATE IV.

Genyornis newtoni:—Tibio-tarsus (right); figs. 1-7.

Fig. 1. Anterior surface.
2. Posterior surface.
3. Internal surface.
4. External surface.
5. End contour of proximal extremity.

Figs. 1-5 represent one of the largest pair in the collection (No. I. of table I.)

6. Anterior surface of lower end of another and rather smaller specimen in which the extensor bridge has been well preserved.
7. End contour of distal extremity. The upper margin corresponds to the anterior surface.

Index to Letter References.

A Intercondylar eminence.
B Rotular or cnemial channel.
C Cnemial process.
D Inner border of cnemial process.
E Epi-cnemial crest.
EC Ecto-condyle (of both upper and lower ends).
F Pro-cnemial crest.
G Ecto-cnemial crest.
H Hamular process of ecto-cnemial crest.
IC Ento-condyle (of both upper and lower ends).
J Ecto-cnemial cavity.
K Continuation of pro-cnemial crest.
L Inner border of extensor groove.
M Outer border of extensor groove.
O Articular surface for fibula.
P Tuberosity.
Q Ent-epicondylar depression.
R Ent-epicondylar tuberosity.

Fibula (left); figs. 8 and 9.

Fig. 8. External surface.
9. Internal surface.

Index to Letter References.

A Depression on inside of head (upper articular surface).
B Lower articular surface.
C Tuberosity.

All the figures are half size.

EXPLANATION OF PLATE V.

Genyornis newtoni:—Tarso-metatarsus and Toes (right); figs. 1-6.

Fig. 1. Anterior surface of tarso-metatarsus with upper surfaces of phalanges.
2. Posterior surface of tarso-metatarsus with lower surfaces of phalanges.

Fig. 3. End contour of proximal extremity of tarso-metatarsus. The upper margin corresponds to the posterior surface.

4. End contour of distal extremity of tarso-metatarsus. The upper margin corresponds to the anterior surface.

5. Contours of proximal ends of proximal phalanges. The upper margin corresponds to the dorsal surfaces.

6. Outer surfaces of phalanges.

INDEX TO LETTER REFERENCES.

A Elevated lip of ento-condyle.
B Anterior intercondylar process.
C Hypotarsus.
D Bridge covering posterior ent-interosseous canal.
E Anterior interosseous depression.
EC Ecto-condylar surface
F Nutrient arterial foramen.
G Groove on posterior surface leading to inner intertrochlear inter-space.
H Keel like process on outer side of upper extremity.
IC Ento-condylar surface.
J Posterior ect-interosseous canal.
K Ecto-trochlea.
L Ento-trochlea.
M Meso-trochlea.
N Foramina above ecto-trochlear interspace.
II. Proximal phalanx of inner toe.
III. Proximal phalanx of middle toe.
IV. Proximal phalanx of outer toe.

The other phalanges of each toe are placed in their proper relative order.

All the figures are half size.